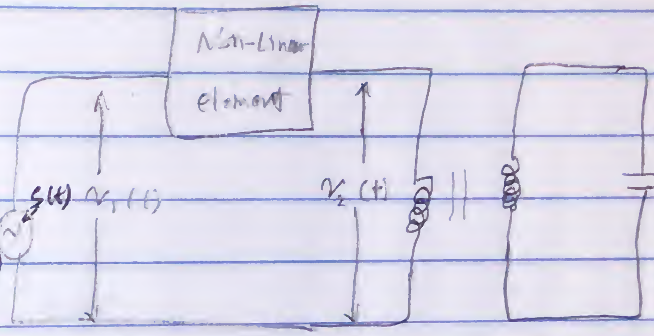
Recover
~~Detection~~

Demodulation of AM Waves:

$$\underbrace{s(t)}_{\text{AM wave}} = A_c\left[1 + K_a \underbrace{m(t)}_{\text{baseband signal message}}\right] \cdot \cos(2\pi f_c t)$$

① Squar-Law Detector:



Low-Pass Filter
2W

$$v_2(t) = a_1 v_1(t) + a_2 v_1^2(t)$$

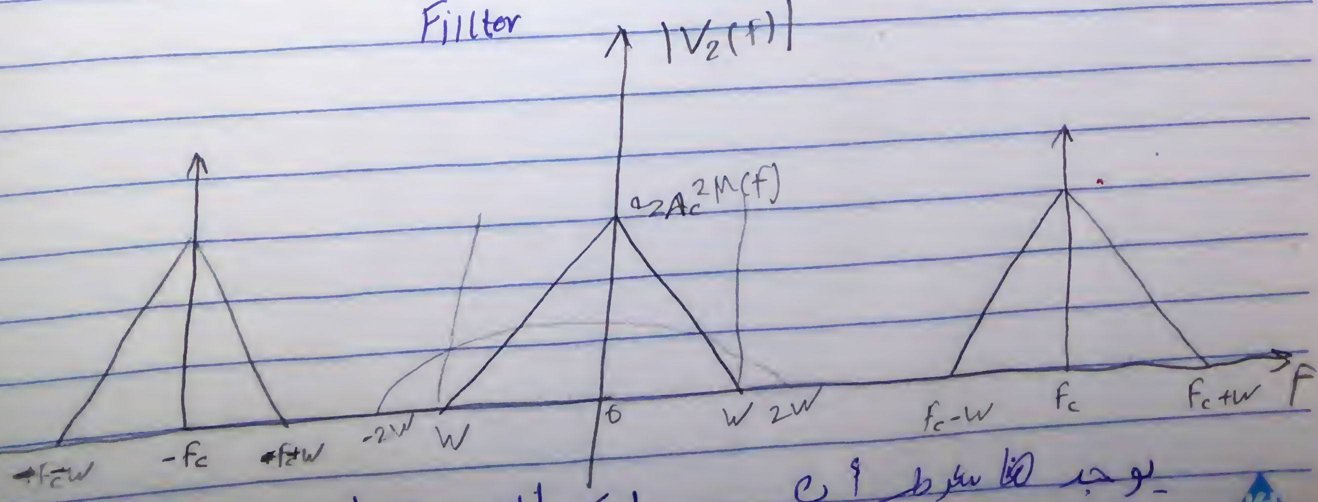
$$v_2(t) = a_1 A_c\left[1 + K_a m(t)\right]\cos(2\pi f_c t)$$

$$+ a_2 A_c^2\left[1 + 2K_a m(t) + K_a^2 m^2(t)\right]\underbrace{\cos^2(2\pi f_c t)}_{\frac{1}{2}\left[1+\cos(4\pi f_c t)\right]}$$

$$v_2(t) = a_1 A_c\left[1 + K_a m(t)\right]\cos(2\pi f_c t) + \frac{1}{2}a_2 A_c^2 + a_2 A_c^2 K_a m(t)$$

$$+ \frac{1}{2}a_2 A_c^2 K_a^2 m^2(t) + \frac{1}{2}a_2 A_c^2\left[1 + 2K_a m(t) + K_a^2 m^2(t)\right]\cos(4\pi f_c t)$$

الإشارة الوحيدة التي تمر من خلال Low-pass Filter



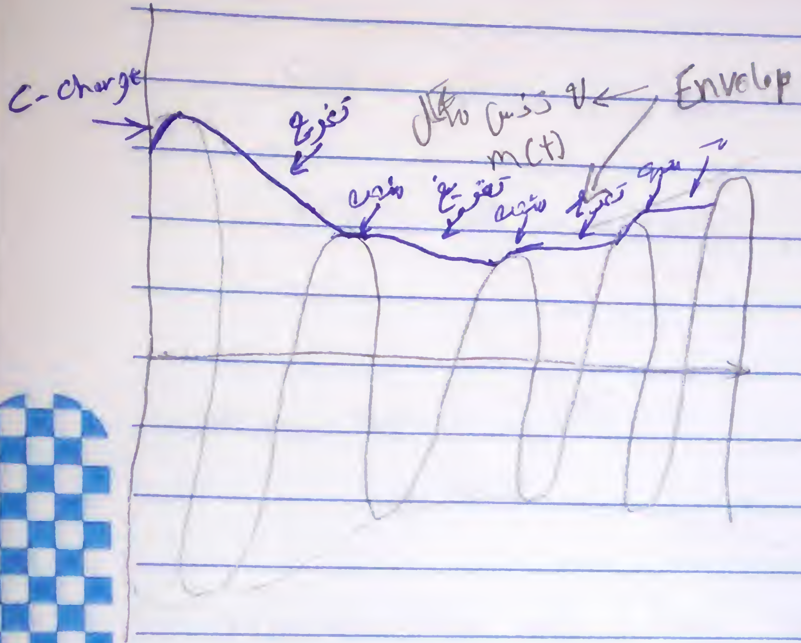
يوجد هنا شرط ؟

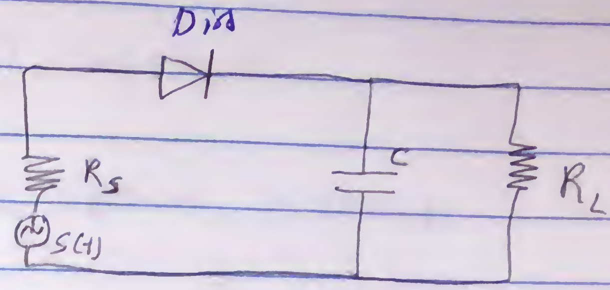
$$|K_a m(t)| < 1$$

وهذا بيقلل تأثير $m^2(t)$

② Envelope Detector :

الأكثر استخداماً





$|K_a\, m(t)| < 1$

S(t) → high value Diod ON

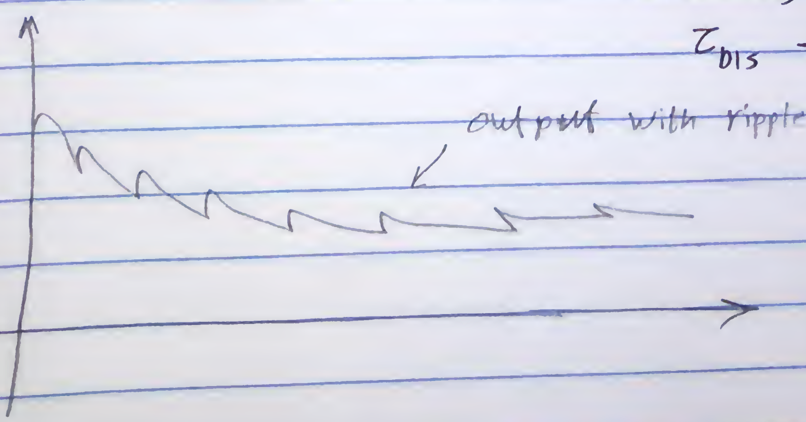
C → charging

Charging time $= R_s C < \frac{1}{F_c}$

τ_c → very small

Dis charging time $= R_L C < \frac{1}{W}$

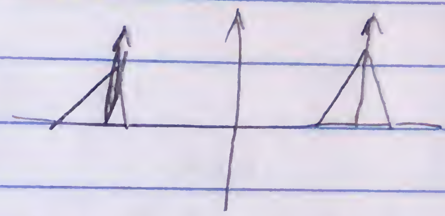
τ_{DIS} → كبير



$$S(t) = A_c\,[1 + K_a\,m(t)]\,.\cos(2\pi f_c t)$$

$$S(t) = \underbrace{A_c \cos(2\pi f_c t)}_{\substack{C(t) \\ \text{Carrier}}} + \underbrace{K_a A_c\, m(t)\,.\cos(2\pi f_c t)}_{m(t)\,.\,c(t)}$$

عند إرساله يحدث فقد
في القدرة



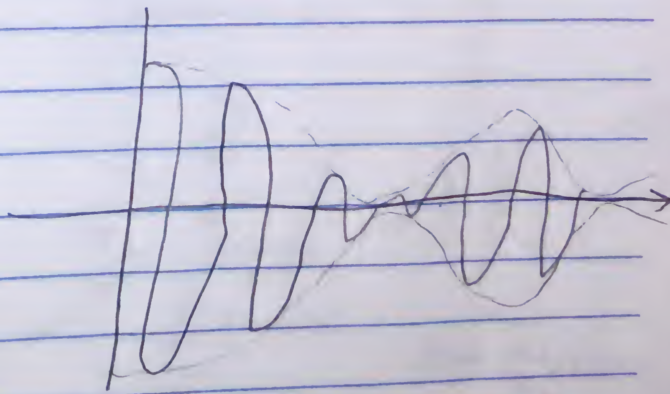
Double-Side band - with Suppressed Carrier

يتم إزالة Carrier عند الإرسال

$$S(t) = C(t)\,.\,m(t)$$

$$S(t)\Big|_{DSB.SC} = A_c\, m(t)\, \cos(2\pi f_c t)$$

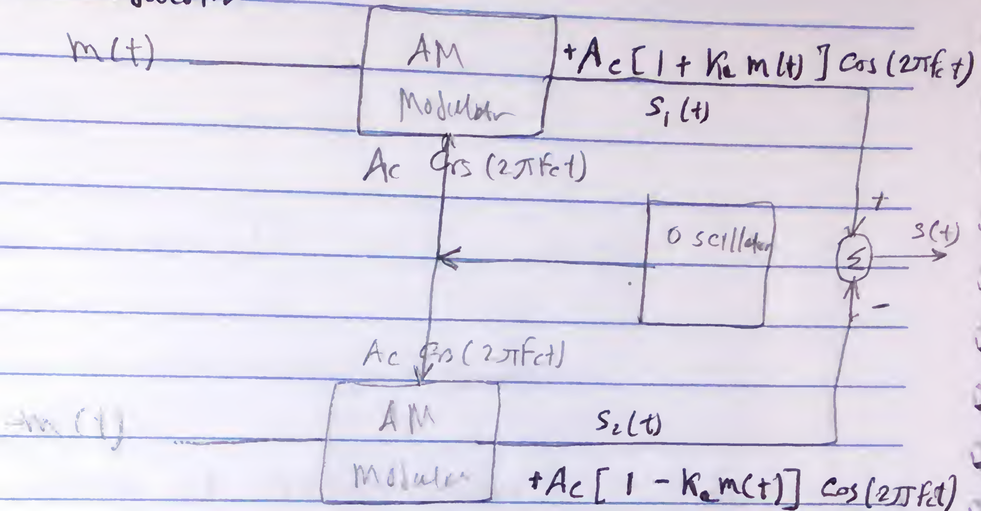
DSB-SC In Frequency Domain



DSB-SC in time Domain

① Modulator for DSB-SC :

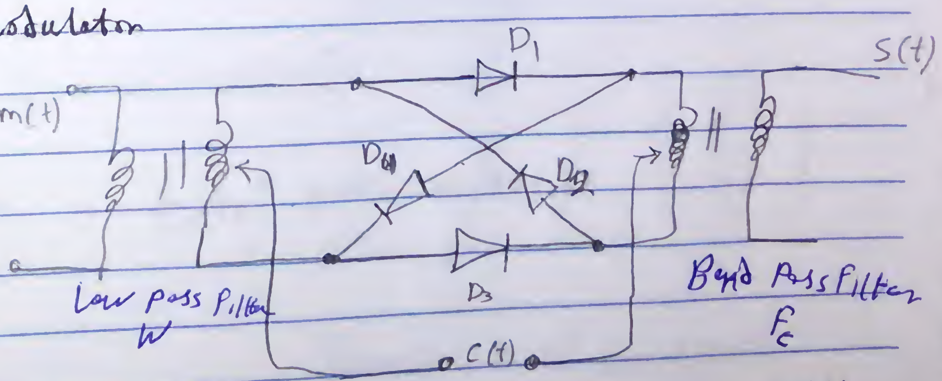
[1] balanced modulator



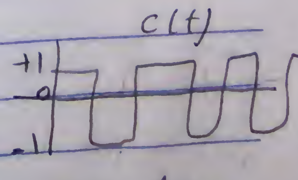
$$s_1(t) = A_c[1 + K_a m(t)] \cos(2\pi f_c t)$$
$$s_2(t) = A_c[1 - K_a m(t)] \cos(2\pi f_c t)$$

$$s(t) = s_1(t) - s_2(t)$$
$$s(t) = 2 A_c K_a m(t) \cos(2\pi f_c t)$$

[2] Ring Modulator



$c(t) \rightarrow$ positive
↳ D_1, D_3 ON
↳ D_2, D_4 OFF



pulse train

$c(t) \rightarrow$ Negative
↳ D_2, D_4 ON
↳ $D_{1,3}$ OFF

$$C(t) = \frac{4}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2^{n-1}} \cos\left[2\pi f_c t (2n-1)\right]$$

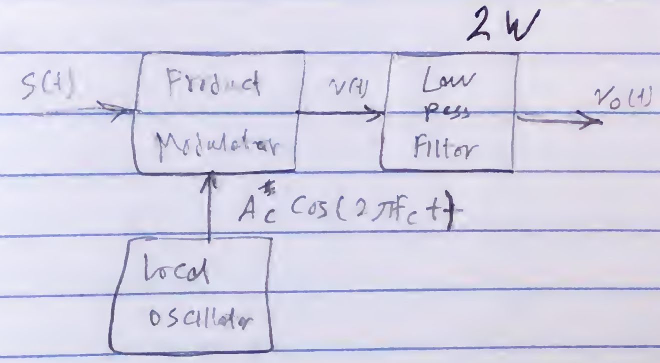
$$S(t) = C(t) \cdot m(t) \qquad (n=1)$$

$$\boxed{S(t) = \frac{4}{\pi} m(t) \cos(2\pi f_c t)}$$

* Detection of DSB-SC:

① Coherent detector of DSB-sc wave

$$S(t) = A_c\, m(t) \cos(2\pi f_c t)$$



$$S(t) \cdot C(t)$$

$$= A_c^2\, m(t) \cos^2(2\pi f_c t)$$

$$= \frac{1}{2} A_c^2\, m(t) \left[1 + \cos(4\pi f_c t)\right]$$

$$V(t) = \underbrace{\frac{1}{2} A_c^2\, m(t)}_{V_o(t)} + \frac{1}{2} A_c^2\, m(t) \cos(4\pi f_c t)$$

الأول في local oscillator

$A_c' \cos(2\pi f_c t + \phi)$ يوجد بها خطأ

$A_c' \cos(2\pi (f_c + \Delta f) t)$

خطأ في ϕ

أو f_c

Detection لل ~~..~~ اسمه وده

Page :
Date :

phase error

$$c(t) = A_c' \cos(2\pi f_c t + \phi)$$

$$v(t) = A_c A_c' \cos(2\pi f_c t) \cos(2\pi f_c t + \phi) \cdot m(t)$$

$$= \frac{1}{2} A_c A_c' m(t) [\cos(4\pi f_c t + \phi) + \cos\phi]$$

$$V_o(t) = \frac{1}{2} A_c A_c' m(t) \cos\phi$$

$\phi = 0 \rightarrow$ out ✓
$= 90 \rightarrow$ out 0 ✗

Report $\rightarrow$ frequency error